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STOCKS OF *NEPHROPS NORVEGICUS* OFF THE SOUTH COAST OF IRELAND

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Nephrops norvegicus is also known popularly as the Dublin Bay Prawn or Norway Lobster. In this paper it will be referred to simply as the "prawn".

The stocks of prawns in depths down to 60 fathoms (109 m) have been studied since 1956, off the south of Ireland, from Mine Head, Co. Waterford, to the Kenmare River, Co. Kerry. Accounts of this work have been published by Gibson (1959) and O'Riordan (1964). The present paper is concerned with data obtained from the research vessel, *Cú Feasa*, together with other samples collected from commercial fishing boats, during the years 1963 to 1966, inclusive.

Body proportions. Measurements have been based on the carapace, the distance from the back of eye socket to the distal margin being recorded (Fig. 1). The length of the carapace can be measured rapidly and accurately so that large numbers of prawns can be handled in a short time. For any given length of carapace (C), a simple conversion factor may be used to determine total length (Fig. 2) as follows:—

$$\text{Total length} = 3.068C + 5.08$$

No significant difference was found in the ratios of carapace to total lengths in males and females. Males up to 60 mm carapace length (190.2 mm total) have been recorded from these waters. Very few females over 40 mm (127.8 mm total) have been noted. It is also possible to provide similar conversion factors for total weight and tail weight and tail weight and meat yield, as follows:—

	Males	Females
(i) Body weight/tail weight	$3.34x - 4.335$	$2.09x + 0.813$
(ii) Tail weight/meat weight	$1.45x + 0.327$	$1.26x - 0.034$

In Figs. 3 and 4 these relationships are shown diagrammatically. The weight of the tail is almost exactly one-third that of the whole prawn in the case of males (Fig. 3), and in the case of females the ratio of the whole weight to the tail weight is nearer 2:1. The weight of meat extractable from the tails of male prawns is practically 7/10ths of the total tail weight (Fig. 4). After 24 hours out of water, the weight loss can be as much as 10%, thus the meat from the tails might then fall to 3/5ths of the total tail weight. Female prawn tails will produce more meat than males (Fig. 4).

Length frequencies. Details of the length frequency distributions for males and females are given in Figs. 5 and 6, respectively. Whereas lengths of males vary from 22 mm to 60 mm, females enter the catch at 18 mm but are rarely caught larger than 40 mm. The July and August samples of males from the research vessel were unselected so that small prawns were well represented (Fig. 5). The November samples of males were taken from commercial boats and had been selected before being landed, so that there was an apparent improvement in average size due to this (Fig. 5).

The greater part of the prawn catch now goes to factories to be processed. Here, emphasis is placed upon the size of prawn received. O'Riordan (1964) states that there is a growing demand for prawns with a carapace length of 27 mm and upwards. He also states that prawns with a carapace length of 34 mm are considered to be of good quality. He was referring to the Irish Sea, where, on average, the prawns caught are smaller than off the south coast. It is evident from Figs. 5 and 6 that south coast prawns landed have an average size of over 34 mm in the case of males and that many of the females exceed this size as well. At present, therefore, prawns of good quality are landed from this area.

It is difficult to point out a particular trend from Figs. 5 and 6, due, perhaps, to the fact that these stocks have not been fished heavily over a long period of time as in the case of those in the Irish Sea. The catch has not so far levelled off from the effects of fishing. The size range of the prawns in the south coast stocks is wider and their average size is larger than in the Irish Sea. The number of prawns of over 40 mm indicates that natural replenishment of the stocks still exceeds the quantities being removed by fishing.

Male/female ratios. The ratio of the sexes takes on a special significance in the case of prawns. Firstly, female prawns of over 40 mm are so rare as to be commercially unimportant. Secondly, females are largely absent from the catch at certain times of the year. Thirdly, the majority of females are in the 30 to 34 mm length range (Fig. 6). The importance of this length range is discussed in the section dealing with maturity.

The ratio of males to females changes according to the time of year. Thus, in July (Fig. 7) as much as 54% may consist of females. By August this may drop to 16 to 20% and by November be as low as 4% in the samples (Fig. 8). The reduction to a figure as low as 4% is due in some measure to discarding of small prawns at sea. Even if the small prawns had been retained, females would not have exceeded 10% to 15% of the catch in November. Since, as has been stated before, female prawns are on average smaller than males, the most suitable time to commence annual fishing is when males predominate in the catch. Fishing is most actively pursued on the south coast in autumn, winter and early spring. Late spring (April) and summer fishing does take place and on average the size of prawn taken at this time of year, males and females combined, lies in the 30 to 40 mm range. Later, from October to March, the overall size ranges from 35 to 45 mm, due entirely to the disappearance of females, together with selection of small prawns out of the catch at sea.

Maturity and moulting. Females have been observed to carry their eggs for the first time at a length of 20 mm. The mean size of females caught was approximately 31 mm and these were all mature. Since females bearing eggs are the mainstay of the stocks, there might be some merit in protecting them during the late spring and summer months, especially from July to September when they are numerous in the catch. Little is known about the size at which males mature, but in other closely allied species they do so at a somewhat smaller size than females.

Observations of soft shelled males and females in the catches have been made. It seems likely that there is a large scale moult of females in summer. These females harden after about three weeks so that they appear in the catches in considerable numbers in late June, July and August. After the females moult and harden it seems likly that the males then moult. Thus, soft and hardening males appear in the catch in August and sometimes in September. By October most males are hard and also females bearing their eggs disappear from the catch. A sample of 665 unselected prawns examined late in April, 1966, however, exhibited characteristics which suggest that the summer and autumn material of three previous years was not representative of the annual pattern of moulting and maturity. This sample contained 50% of females. Of these, 40% were very soft, as though recently moulted and the balance were very clean shelled and appeared to have been hardened only for a short time. To emphasize the importance of this observation the maturity stages of the gonads of these females ranged from early development to those in which the ovary is rounded and the ova clearly visible. Therefore, the precise time of moulting has not been established. For example, in July, 1963, 3% of the females were ovigerous, carrying bright green ova of recent emergence. In the same sample, 57% of these females were in stage V of maturity in which the ovaries are full sized and project forward into the eye sockets. This is the stage immediately preceding the emergence of the ova and their attachment to the abdomen. In the April, 1966, sample, 58% of the ovaries were in stage IV of maturity in which they are rounded with clearly visible eggs of a deep green colour. Whilst the July, 1963, and April, 1966, data suggest that there is a steady development of the ovaries from March onwards, the questions remain as to when moulting takes place and whether or not females are ovigerous annually. The summer and autumn data for 1963, 1964 and 1965 suggest that moulting in females takes place in or about June and July because of the number of soft shelled specimens in the samples at that time and in August. However, 40% of the females in April, 1966, were also in the soft shelled condition so that they must have moulted earlier in the spring of 1966. The evidence given by Karlovac (1953) and Thomas and Figueiredo (1965) makes it most unlikely that females become ovigerous every alternate year. An alternative to biannual moulting is that in some years when hatching is complete by the end of February, this is followed by moulting and fertilization. In this way, progressive waves of females would moult and be re-fertilized from the early part of the year right through to the summer period of June and July.

It is important that the average size of females caught should be maintained at a suitable average size. Because egg bearing has been observed to be complete when prawns have a carapace length of 26 mm, it is important that as many of these mature females as possible escape. In Fig. 6, it is evident that females of 26 to 29 mm carapace length range which in nature are numerous, escape the net in large numbers, since they are poorly represented in the catch. Therefore, if the average size of females caught remains at or above 30 mm adequate breeding stock is assured. However, if the average size of females falls below this length, it would suggest overfishing.

The disappearance of females in the early and late part of the year

is attributed to the fact that at that time they are egg-bearing and probably occupy a position on the sea-bed which is not readily accessible to fishing. Thus they are able to incubate and hatch their eggs in comparative safety, the nature of this process not being understood at present.

Tagging. Attempts were made to determine the density of prawns in an area 3-4 miles south and east of Galley Head. The area was first charted by Decca and found to be 4.5 square Km in extent. The bottom consisted of fairly well compacted mud and fine sand, suitable to prawns.

Taggging was accomplished by placing a coloured rubber band over the right cheliped using a special tool to put the band in position. The prawns tagged were of all sizes and so the rubber bands were of different colours and different sizes to distinguish the various size groups. Prawns were held for tagging in canvas tanks, through which water was continuously pumped, rigged on the deck of the ship. The method of tagging was quite slow and, therefore, a considerable portion of the prawns in the tank were too weak to be tagged on each occasion.

Details of the liberated tagged prawns are given in Table 1. It will be seen that a total of 2,204 prawns were tagged and liberated from August 5th to 7th, 1964. These ranged in carapace length from 20 mm to 50 mm but the majarity were about 40 mm. The tagged prawns were not fished until the 10th of August, three days later, in order to give them an opportunity to mix thoroughly with the untagged population. The numbers of recaptured prawns in the various sized categories are given in brackets in Table 1, and it is possible to obtain a rough idea of the total number of prawns in this area, the details being as follows:—

Carapace length in mm	Numbers released	Numbers recaptured	Numbers in catch	Estimated population (nearest thousand)
20-29 mm	429	2	2,537	544
30-39 mm	892	4	4,799	1,070
40-49 mm	815	9	2,283	207
50-59 mm	68	2	479	16
			Estimated total population	1,837

There is no doubt that the low number of prawns in the size range 20 to 29 mm may be attributed to the number of this size which escape from the net. Thus the minimum density per square Km is approximately 406,000 of which about 75% are commercial sized in the catch.

Summary and Discussion

(i) A description of basic measurements is recorded.

(ii) The significance of the large average size of the prawns caught is discussed.

(iii) From the length frequency studies of both males and females it appears that the south coast stock is viable.

(iv) An attempt is made to assess the numbers of prawns occurring naturally per square Km. by the recapture of tagged prawns. These estimates of population size suggest that the stock is in a healthy state.

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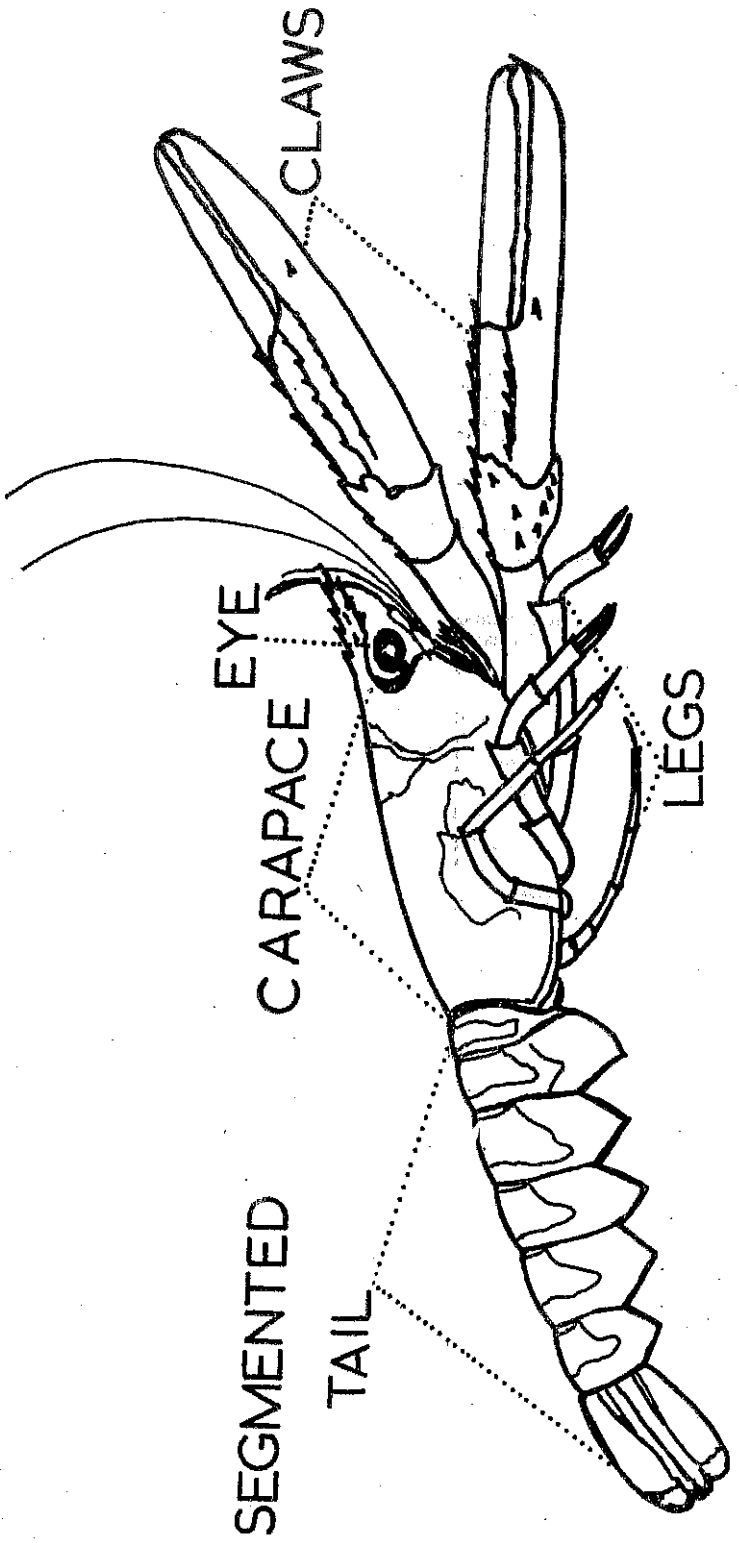

Fig. 1

Side view of prawn, showing dimension used for measuring carapace length.

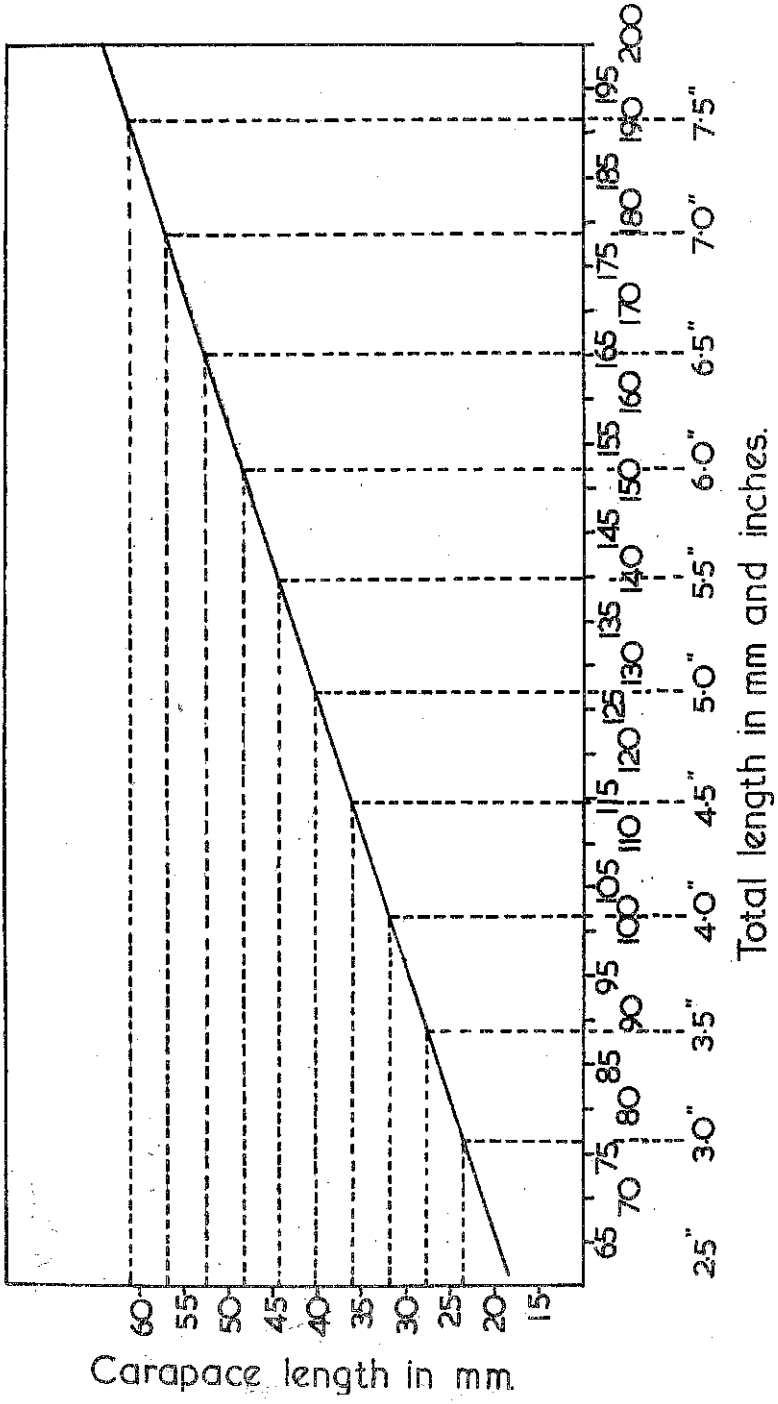

Fig. 2

Relationship between carapace and total length in prawns, irrespective of sex, shown in metric form and in inches.

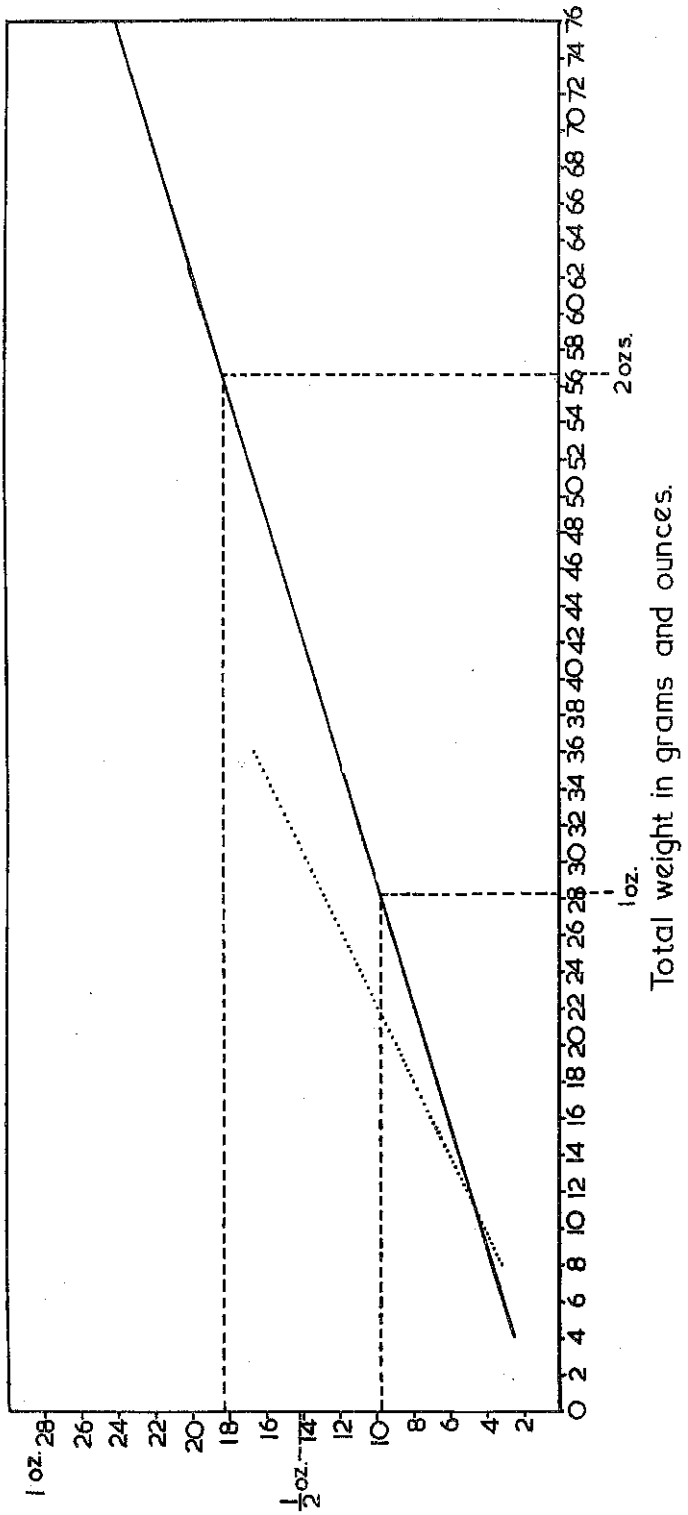

Fig. 3

Metric relationship of total prawn weight to tail weight for males (solid line) and females (dotted line), with selected avoirdupois comparisons.

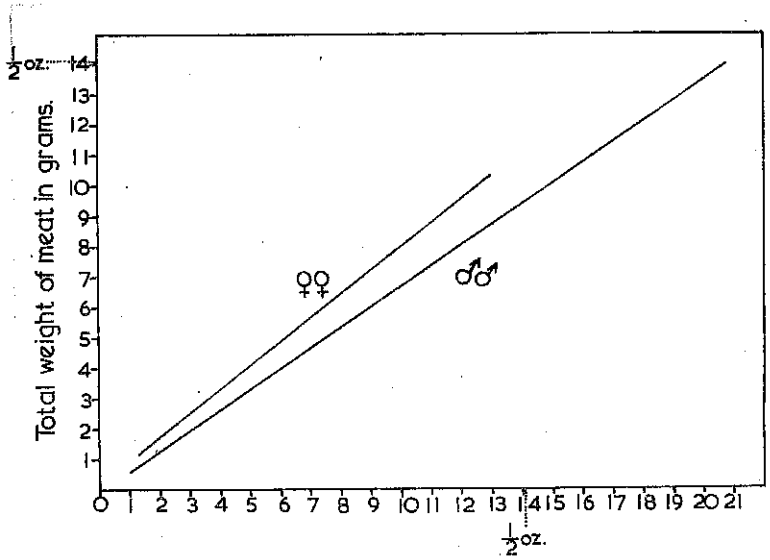

Fig. 4

Metric relationship of total tail weight to the expected yield of meat for males and females, with selected avoirdupois comparisons.

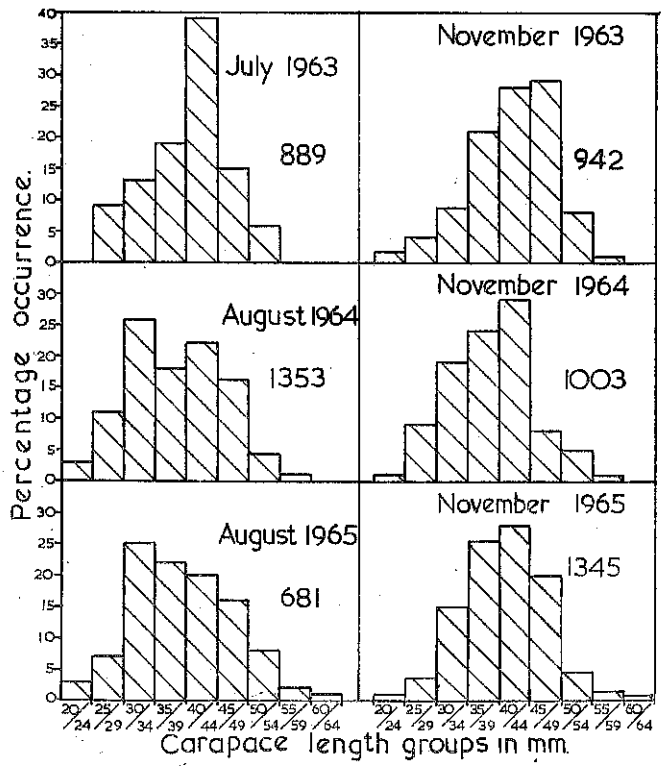

Fig. 5

The size frequency distribution of the catch of male prawns during part of the summer (by research vessel) and part of the winter (commercial vessels).

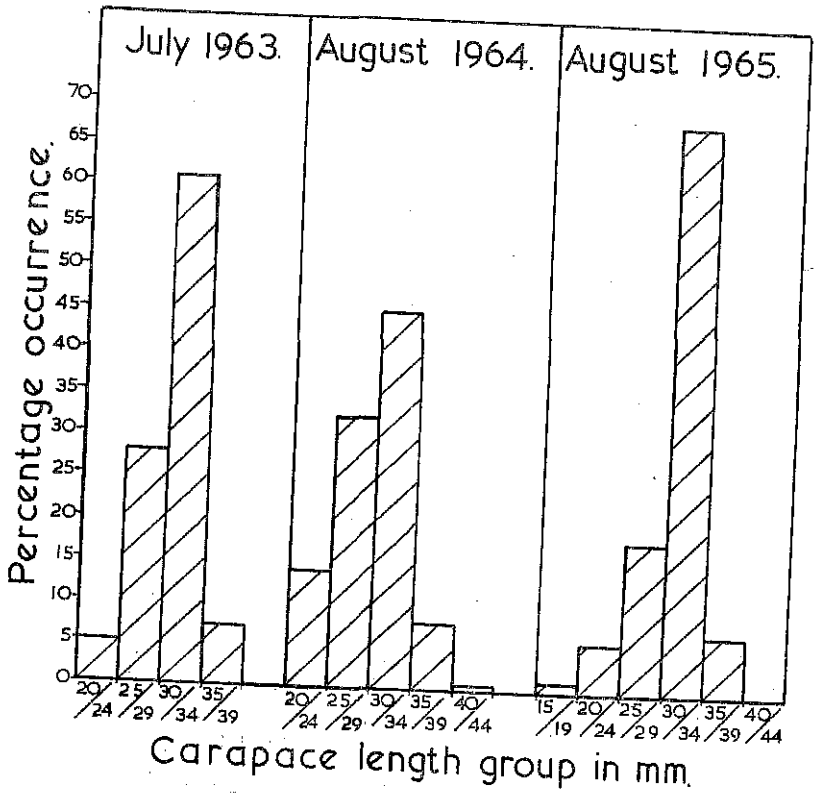

Fig. 6

The size frequency distribution of female prawns during part of the summer taken by research vessel.

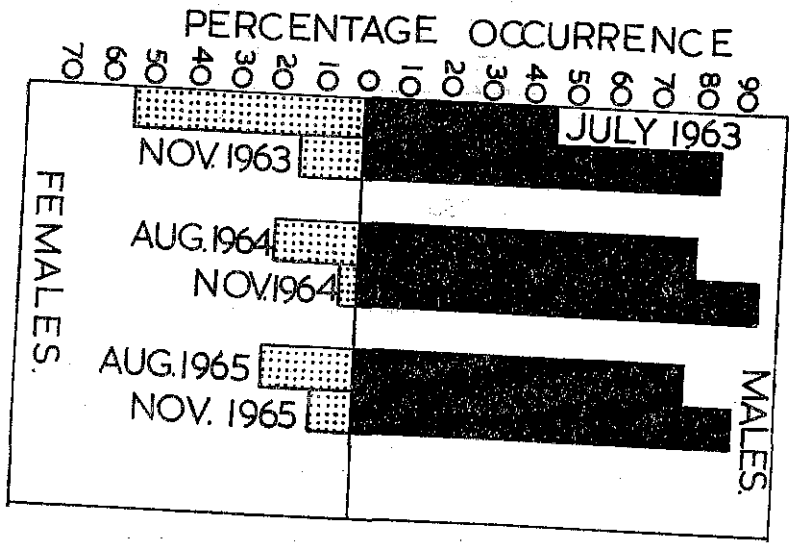

Fig. 7

Comparisons of the ratios of males to females in the catch between a summer and winter period from 1963 to 1965.

Table 1.—Details of tagged prawns liberated near Galley Head, August 5th to 7th, 1964, together with recaptures of tagged and untagged prawns from August 10th to 13th, 1964

	Males and Females					
Carapace length mm. ...	20-29 mm.	30-39 mm.	40-49 mm.	50-59 mm.	Total tagged	
August 5th - 7th August ...	429	892	815	68	2204	
					Total recaptured	
Recaptured totals	2	4	9	2	17	
Tagged and untagged totals						
					Total caught	No. tags
10/8/64	62	195	86	32	375	Nil
11/8/64	46	182	68	23	319	Nil
12/8/64	760(2)	1496(1)	600(2)	133	2989	5
13/8/64	1420	2537(2)	1228(5)	196(1)	5379	8
14/8/64	249	389(1)	301(2)	95(1)	1036	4
Total untagged (all sizes) ...	2537	4799	2283	479	10,098	